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AMERICAN FOUNDRYMEN'S ASSOCIATION.

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The American Foundrymen's Association is not responsible for any statement or opinion that may be advanced by any contributor to this Journal.

PROCEEDINGS OF THE PHILADELPHIA FOUNDRYMEN'S ASSOCIATION.

A regular meeting of the Philadelphia Foundrymen's Association was held at the Manufacturers' Club, in Philadelphia, on Wednesday, September 6, the President, P. D. Wanner, occupying the chair.

The Executive Committee made a report, as follows:

"This is our first meeting after the summer recess. A number of changes have taken place of much interest to the trade, notably the rise in pig iron prices of $3 to $4 per ton. This in itself should have the effect of raising the price of castings sufficiently to cover the advance. We would also mention that advances have been made in the prices of many other articles affecting the foundry trade; for instance, plumbago, used for making foundry facing and blacking, steel wire for making cleaning brushes, bristles for making dust brushes and scrubs, steel for making shovels, riddles, tools of various kinds, coke and coal. In fact, nearly every article used in making castings has advanced. We call the attention of all foundrymen to these matters, that the importance of advancing the prices of castings to a degree commensurate with the advances noted may be seen. Another question which foundrymen would do well to consider is the apparent scarcity of good molders, core makers and patternmakers.

"We find that through the instrumentality of some of the local foundrymen's associations in different parts of the country card prices have been adopted at which castings are to be sold, among them Pittsburgh and Milwaukee, and there seems to be no trouble in maintaining these prices. There is more foundry work offering than there are foundries to turn it out, and if you will stop to consider the situation we think you will decide with us that the foundry business, in iron, steel and brass, is in a very prosperous condition. We find, further, that nearly all of the foundries in and about Philadelphia have all they can do, and a little more, to keep pace with their orders. While it is not the intention of this association to make a card price for either castings or labor, we trust this report may have the effect of encouraging foundrymen to exact their just dues."

Orr, Painter & Co., Reading, Pa.; P. Kennedy, Baltimore, Md., and Matthew Addy & Co., Cincinnati, Ohio, were elected to membership in the association.

The Secretary read a letter from C. A. Sercomb, President of the Milwaukee Foundrymen's Association, in which reference was made to an agreement existing among the foundrymen of Milwaukee as to prices, and to an accompanying booklet containing a classified list of articles entering into the general product of foundries and the prices at which such articles were to be sold.

Mr. Sercomb referred to the booklet as covering the first system of its kind ever adopted in the foundry trade, and as having originated with the Milwaukee Foundrymen's Association, the object of which association was to eliminate abuses in the trade in general by harmonious and concerted action.

Reports being called for from the members present as to the condition of trade in their respective sections, it was, without exception, reported that there was plenty of business offering and prices of castings had been advanced ½ cent to 1 cent per pound. As indicating the pressure of business existing, one member stated that he was compelled to turn down orders granting 60 and 90 days for delivery.

W. C. Henderson, who was introduced as having just returned from a sojourn in the Klondike, gave an interesting description of the country. Speaking of the possibilities open to foundrymen, he said that at present there were no foundries in the Klondike or adjacent territories, but a foundry would probably be started at Dawson City this year. Until coal would be in supply the only fuel for melting iron available would be cord wood, and this the foundryman would have to chop for himself.

Under the head of new business several topics were presented for discussion, among them "How to Keep Good Molders." In the discussion of this topic it appeared to be the general opinion that the best way to keep a good molder was to make his surroundings as pleasant as possible, and provide convenient bathing and dressing rooms for his use. Mr. Cook, superintendent of the foundry at the Washington Navy Yard, said the windows in his foundry building were washed twice a year and the interior of the foundry was whitewashed once a year. Molders, he said, pass the best part of their lives in foundries, and therefore the foundries should be kept as clean, bright and orderly as possible. Teach the men to respect themselves and live tidy and genteel lives.

The meeting concluded with an exhibition of lantern slides covering various subjects, by John Birkinbine, who gave running descriptions of the subjects in his usual happy style.

PROCEEDINGS OF THE PITTSBURG FOUNDRYMEN'S ASSOCIATION.

The Pittsburg Foundrymen's Association held its first meeting after the summer vacation Monday evening, September 25, at the headquarters, Frohsinn Building, Pittsburg. The main feature of the evening, besides the nomination of officers, was the presentation of a series of stereopticon views of various departments of the famous Sulzer Bros. foundry at Winterthur, Switzerland. Dr. R. G. G. Moldenke accompanied the views with a running description of the plant.

A committee was appointed to nominate officers for the election at the October meeting, and the committee reported as follows: President, Dr. R. G. G. Moldenke, of the Pennsylvania Malleable Co.; Vice-Presiednt, Phillips Mathes, of the Brittan & Mathes Co.; Secretary, F. H. Zimmers, of the Union Foundry and Machine Co.; Executive Committee, I. W. Frank, Wm. Yagle, Robert Taylor, B. D. Fuller and E. A. Kebler. Mr. Zimmers is the present Secretary. The President, Secretary and Treasurer are ex-officio members of the Executive Committee. The members did not add any names to those placed in nomination by the committee.

MILWAUKEE FOUNDRYMEN'S ASSOCIATION.

This association has classified the general run of foundry work and adopted a set of prices based upon the cost of labor and material in force October 1, 1899, which we herewith reproduce:

Trial Castings—Time to be charged at 50c per hour. Iron 3c per lb.

Foundry not to stand loss from warping or bending of long plates and moldings or from poor patterns.

Time on patterns to be charged at 50c per hour.

ARCHITECTURAL.

	per lb.
Columns, 500 lbs. and under, faced	4c
500 to 1000 lbs., faced	3c
1000 lbs. and over, faced	2¾c
Column plates, bolsters, post caps, bases, wall plates, wall anchors and lintels. Machining extra	2½c
Cresting	7c
Sill plates, step plates, platforms and risers, stringers, sidewalk tiles and frames, sidewalk rings and covers	4c
Ornamental work, facia, shell caps and bases, moldings, etc., not less than ⅜ thick	5c
If above is for plating, additional	1c
Fence posts and post caps, ⅜ thick	5c
Sash weights (grey iron)	2c
Special	3c

AIR BRAKE.

Air Brake Casting	4½c

See bench list for light castings.

AGRICULTURAL.

Frames, gear boxes, pinions, etc........................3½c
Fanning mill castings 4c
Couplings (threshing machine)...........................3½c
Smutters and dust collectors, large pieces..............3½c
For small castings see Bench Work List.
Pump handles 4c

BENCH WORK—Gated.

Castings that weigh 1 lb. or under, per flask............6 to 20c
1 to 1½ lbs., per flask.................................6c
1½ to 2 lbs, per flask..................................5c
Over 2 lbs., per flask..................................4c
The above prices are for large orders.
Bed plugs 7c
Punch bag castings......................................7c

BOILER CASTINGS—Steam.

Fire fronts, including boiler, fire fronts and ash pit doors...2¾c
All other boiler castings, such as grate bars, bearings for grates, buckstays, cleaning doors and frames, wall plates, arch bars, boiler brackets, stack plates, etc...............2¾c
Rocking and shaker grates...............................4c
Above to consumers direct, extra........................½c
Fitting fronts, extra...................................¾c
Use of foundry patterns (additional)....................¼c

BRICK YARDS.

Grates, see Boiler List.
Dampers and brick machinery.............................3½c

BRIDGE CASTINGS.

Bridge castings for city repairs from old castings...........4c
Bridge wheels, chilled or turned, for repairs...............4c
Large orders (machine work extra).......................3½c
Bridge work castings at architectural list (including posts and railings).

General price for Bridge Shops:

Up to 100 lbs 3c
100 to 500 lbs 2¾c
500 to 1000 lbs 2½c
Over 1000 lbs 2¼c

For special cored castings add ¼c to above prices.

ELECTRICAL.

Dynamo . . . . 3½ to 4c
Small parts of same . . . . 4 to 5c

ELEVATOR.

Weights 2c
Hydraulic cylinders 3½c
Elevator and conveyor casting, except sprocket wheels 3¼c
Cast sheaves for wire rope up to 20 inches in diameter 3½c
20 inches to 60 inches diameter and larger 3c
Cast sheaves for Manila rope, 5 feet to 6 feet, inclusive 4c

FANS.

Spiders, pedestals, stands, etc., for fans 3¼c

FURNACE—Jobbing.

Fire pots 6c
Other furnace castings 6c
Furnace repairs . . . . 6 to 10c

GAS AND GASOLINE STOVES.

Gas and gasoline stove castings . . . . 7 to 12c

HARDWARE.

Boiler handles 3½c

	List.
Hooks (clothes line), No. 1, per doz	$1.30
No. 2, Jap, per doz	.75
No. 3, Jap, per doz	.60
Hooks (hat and coat)	....
Hooks (wardrobe)	....
Hooks (harness)	....

Door pulls ....
Door track rails ....
Door check back rails.......................... ....
Hitching posts ....
Post mauls ....

Ash Pit or Flue Doors—Japanned:

Sizes, in ..	8x8	8x10	10x12	10x14	12x15	16x16	16x20
Per doz ..	$6.00	$6.60	$9.00	$10.00	$12.80	$17.00	$21.65

Jack Screws—Diameter of screw, 3 inches, 24-inch raise..$2.25
Diameter of screw, 3 inches, 36 in. raise.............. ....

Kettles—(Cauldron and Pail.)	List.
3 Barrel	$18.00
2½ Barrel	12.50
2 Barrel	7.25
1½ Barrel	6.25
1 Barrel	4.50
12 Pail	4.75
10 Pail	4.25
8 Pail	3.50
6 Pail	3.00
5 Pail	2.50
3 Pail	2.25

Discount 35 per cent.

LAWN FURNITURE.

	per lb.
Settees	7c
Vases	7c

Set up add 1c per lb.

LARGE MACHINE SHOP, ENGINE AND PUMP CASTINGS.

	per lb.
Cylinders, Dry Sand or Loam	3½c to 4c
Cylinders, Castings made off one half Pattern, extra	⅛c
Dry Sand and Loam Work	3¾c
Engine Castings, 100 lbs. or under	3¼c

100 to 500 lbs.............3c

500 to 1000 lbs.............2¾c

over 1000 lbs.............2½c

Bed Frames included in above list.

Wheels with Flange included in above list.

Ammonia Castings.............6 to 8c

Rolling Mill Castings.............2½c

Boxes, Hangers, Oil Catchers, etc., and Machine Castings, without many cores, 50 lbs. and under, see classified list above.

Electric Crane Castings under 50 lbs.............4½c

50 to 100 lbs.............3¼c

100 to 500 lbs.............3c

500 to 1000.............2¾c

over 1000.............2½c

GEAR WHEELS.

Gear Wheels, 25 lbs. and under.............5c

25 lbs. to 50 lbs.............4½c

50 lbs and under.............4c

Add 15 per cent to above price for Split Gears.

STEAM PUMP AND MACHINE SHOP—Jobbing.

per lb.

Steam Pump Work, 50 lbs.............3¾c

50 to 100 lbs.............3½c

100 to 500 lbs.............3¼c

500 to 1000 lbs.............3c

over 1000 lbs.............2¾c

Cylinders, plain.............3½c

Cylinders, steam jacketed.............4c

Boxes, Hangers and Machine Castings, see classified list of Large Shops.

MISCELLANEOUS.

Manhole Covers $9.00
Fire Cisterns, Special.
Water Pipe Special Fittings 3c
School Seats, Fronts or Backs 5c
Ink Wells 12½c

STABLE GOODS.

per lb.

Oat Boxes, Hay Racks, Stall Partitions, etc 4c
The Above ¼ thick or less 4¼c
Barn Gutters 4½c
Hitching Posts 4½c
Horse Weights .... 2 to 2½c

SPECIAL CASTINGS—Rough.

Switches, Frogs, Track Castings, per lb 2¼c
Washers, ¾ inch and under, large lots 2⅜c
Washers, over ¾ inch, large lots 2c

STEAM HEATING.

per lb.

Grates per list. (See boiler.)
Heating Fronts and Radiator Stands and Legs 4c
Heating Boilers for steam and water .... 4 to 6c
Water Backs .... 8 to 10c
Heater Bases for coils .... 4 to 6c
Hot Air Blower Castings 1 to 25 lbs.
(See Bench List.)
25 to 100 lbs 4c
100 to 300 lbs 3½c
over 300 lbs 3¼c

STOVE.

per lb.

Stove Repairs .... 6 to 10c

WAGON AND SLEIGH GOODS.

	per lb.
Bolster and Reach Plates	3c
Rub Irons	$2\frac{3}{4}$c
Sleigh Knees and Wagon Brakes	$3\frac{1}{2}$c
Mandrells and Swage Blocks	3c
Sleigh Shoes, car lots	2c
Sleigh Shoes, less than car lots	$2\frac{1}{4}$c
Sleigh Shoes, jobbing special patterns	$2\frac{1}{2}$ to $3\frac{1}{2}$c

WIRE WORK.

Wire Work Goods, see Bench List Prices.

Scroll Work 15c

N. B.—All stopping off and cutting in the mold $\frac{1}{4}$ cent per lb. additional.

Castings delivered within city limits on large contracts free of charge.

Small lots, cartage charged.

TERMS: NET CASH 30 DAYS.

SHRINKAGE OF CASTINGS.

The allowance necessary for shrinkage varies for different metals and the conditions under which they are cast. Castings cast under ordinary conditions, where the thickness runs about one inch.

The following allowance can be made:

For Cast Iron,	1-8	inch per foot.
For Brass	3-16	inch per foot.
For Steel,	1-4	inch per foot.
Malleable Iron,	1-8	inch per foot.
Zinc,	5-16	inch per foot.
Tin,	1-12	inch per foot.

Thicker Castings under same conditions will shrink less, and thinner Castings more than this standard.

WEIGHT OF CASTINGS.

Determined from Weight of Patterns (Rose's Pattern Makers Assistant.)

A Pattern one pound, made of	Will Weigh when cast in Iron. lbs.	Zinc. lbs.	Copper. lbs.	Brass. lbs.
Pine, Red	12.5	12.1	14.9	14.2
Pine, White	16.7	16.1	19.8	19.0
Pine, Yellow	14.1	13.6	16.7	16.0

ESTIMATES.

In making Estimates on work, use the Schedule of prices given for castings, and charge all labor at rates stated.

To arrive at proper charge for,—or to estimate price for castings not in Schedule, use the following method:—

1. Figure iron, melted and poured, at double the market price, AT THE TIME OF MAKING ESTIMATE, of No. 2 X Foundry Pig Iron delivered. (This item is intended to cover the cost of pig iron, waste, coal, coke, laboring help required to handle and pour the iron, and a portion of the general expense.)

2. Double the actual cost of all skilled labor on the job.

3. Add 50 per cent. to the actual cost of all common laboring help on the job.

These three items should, when added together and divided by the number of pounds in casting, give us a fair price per pound for a charge or estimate.

This price is supposed to cover all expense and include a fair profit.

MELTING POINT OF IRON.

PROF. ROBERTS-AUSTIN.

Cast Iron, white, 1922° to 2075°.

Cast Iron, gray, 2228°.

Cast Iron exposed to continued heat becomes permanently expanded 1½ to 3 per cent. of its length.

WASTE OF CAST IRON.

Per cent. of waste of Cast Iron in Melting:

Pig Iron, 2.5 to 4 per cent.

Heavy Machinery Scrap, clean, 3 to 4 per cent.

Assorted Stove Plate, 13 to 15 per cent.

A REVIEW OF THE FOUNDRY LITERATURE OF THE MONTH.

IRON AGE.

The malleable iron industry, which is continually increasing in number, as well as size, of plants, calls forth the following editorial in the Iron Age of September 14:

Manufacturers of malleable castings have never in their history been so driven with work as at the present time. Some remarkable circumstances are reported in this branch of trade. One of the large Western implement manufacturers has for some time been obliged to order daily shipments by express from distant foundries in order to be able to complete implements which only needed the addition of small parts to prepare them for shipment. In other instances implement manufacturers have been compelled to make brass castings to finish machines on which serious delays were threatened by the inability to secure a full supply of malleable castings. In the hardware trade, jobbers have been put to much inconvenience in the slow delivery of hardware specialties which needed small malleable parts to complete them. Malleable foundries have been adding largely to their facilities this year, but in no case have they been able to make their enlargements fast enough to keep up with the growth of their trade. So many new foundries, however, are now being built and arrangements are being made for the construction of others that at an early day it is expected the shortage of production in this branch will be overcome, if indeed the business is not overdone when they all get into operation.

IRON TRADE REVIEW.

In the issue of Sept. 14 Dr. Richard Moldenke reviews an article on "The Elasticity of Chilled and Ordinary Cast Iron," originally published in a German periodical, as follows:

Prof. C. Bach, the well known testing expert, made a series of tests on chilled cast iron recently which are intended to bring

out information on its elasticity heretofore not available. The primary incentive to these experiments was the failure of a ball bearing the wearing surface of which had been chilled. It was desired to make some comparisons of the iron in its natural condition with the same material when chilled, so a number of test bars were cast from the same ladle and subjected to tensile and transverse test for elasticity. The tensile specimens had the form closely followed in the A. F. A series of tests on cast iron, and were in addition ground off square on the ends to admit of compression. The first series of tests was made upon four bars, two of which had been chilled, the mixture used being chill roll iron. The bars were loaded increasingly, the elongation and permanent set being measured in each case. A summary of the results gives the modulus of elasticity of the chilled iron as compared with that of the same iron in its natural state as much less variable and over one-third higher. The actual figures converted into our system are 11,932,500 down to 11,029,500 for the chilled iron, and 8,610,750 down to 7,559,400 for the same iron in its natural state.

The next set of tests were made on four similar bars subjected to compressive forces. The first specimen was chilled on two sides only so that a thin layer of soft iron was observable in the interior. The modulus of elasticity in this case averaged 10,846,000. The second test piece, chilled on all four sides, ran 11,815,700, or somewhat higher, while the last two specimens, in which the iron was not chilled, had an average modulus of rupture of only 8,127,000. A comparison of the two methods would seem to show that the results are closely comparable. The third set of tests was made on six rectangular bars loaded transversely. The distance between supports was 36.36 inches, and the load began with the application of 330 lbs. at the center. From the elaborate table of results the following are taken: Two bars chilled on two sides, or nearly altogether white, averaged 11,281,000 for the modulus of elasticity. Two further bars, chilled on one side, tested chill down, ran 10,158,700. Another two cast the same but tested chill side up, gave 9,675,000, showing the

yielding nature of the soft iron at the bottom of the bar. The last two bars of this set were not chilled, and had an average modulus of elasticity of 8,707,500. A final trial was made with a tensile test bar but turned out of a soft square transverse test specimen. This was loaded to get the modulus of elasticity and then tested to destruction. The drop in the first case to 7,759,400 shows the stiffening effect of the skin of a casting. The tensile strength of the particular iron was 27,000 lbs. per square inch.

MALLEABLE FURNACE PRACTICE AND ANNEALING.

In the issue of Sept. 28 "Furnaceman" contributes an article on "Malleable Furnace Practice and Annealing," which we reproduce herewith:

Never has any metal known to the iron casting industry attained the position now accupied in the commercial world by the malleable casting. Perhaps the most gratifying feature connected with its manufacture arises from the fact that wherever it has been introduced it has always developed, to the exclusion of other metals. There was no decline in its quality which otherwise might have prejudiced the oft-time doubtful purchaser; and this excellence of product is due entirely to the most careful observance of metallurgical operation by those most interested. It is always gaining ground, and when used in castings upon which the service strains are frequent and of varying stress, it has yet to demonstrate a failure. This is best illustrated in the instance of car-building, where the displacement of gray iron has been complete. To-day it is entering slowly and gradually (as it always does) upon a new and very extensive field, namely, stove-building. There will be numbers of reasons advanced against its fitness for this class of work but these objections will be overcome when the application begins in real earnest. We now have malleable "feet," and other parts will soon follow.

As the production of malleable is so at variance with that of gray iron and there are many misapprehensions, often grave enough to retard possible purchasers from specifying it, perhaps

the following brief notes on actual practice may serve to remove some of the doubts upon the subject.

Malleable cast iron is a metal in which, during the process of production, certain quantities of carbon have been removed, thus following a metallurgical law, that the lower the percentage of carbon the softer and more ductile will be the metal. Carbon is present in two conditions in pig iron: graphitic and combined. As graphitic carbon it is supposed to separate on solidification after a fusion; and as combined it produces a white fracture in metal more or less granular. The former will be the soft irons or "grays," and the latter the hard irons or "whites." When a heat is charged into an air furnace the carbon is (generally speaking) in the graphitic condition, and by the oxidizing flame there encountered passes by almost imperceptible gradations into the white or combined condition. There is an intermediate state when the metal is mottled, or having the carbon about half and half, and this is the mottled iron of commerce. There may be combined carbon in gray iron, and conversely white iron may contain appreciable quantities of gray or graphitic carbon. The mode of existence of carbon in iron is determined to a great degree by the conditions of solidification after original casting, and the amount of heat to which it has been subjected. Rapid cooling favors the retention of carbon in the gray iron into white. The amount of total carbon in pig iron, whether it be gray or white, is generally about the same, and its form in one and the other is due directly to a heat condition at the blast furnace. If the iron is very hot, and the percentage of silicon high, the metal will be slow in cooling, and graphitic carbon will be disseminated throughout the mass, giving it the characteristic fractures of a No. 1 and No. 2. If the iron be cold, and the percentage of silicon is low, the carbon by reason of rapid cooling will enter into combination with the iron, and white iron will be the result.

For many years charcoal iron was preferable in malleable casting, as the ores were reduced by charcoal and cold-blast, and really did chill more deeply than other irons; but with the latter

day demand for tonnage, coke iron has been introduced, and in many quarters has entirely superseded charcoal. The form of carbon in pig iron is, therefore, only an accidental mechanical admixture while in the malleable casting it is a definite chemical combination with the iron. The theory of malleable cast iron is to produce a material differing from gray iron in that its carbon has been lowered materially, thus allowing it to withstand blows, etc., without breaking. Malleable cast iron is therefore the result of a process of decarbonization by means of a sesqui-oxide. The latter by imparting some of its oxygen to the carbon in the castings, at a red heat, forms CO, and thus extracts the carbon. The theory is that any substance having an affinity for carbon, will extract carbon under a heat condition. This feature is now accomplished by packing the castings in rolling mill scale treated with a mixture of sal-ammoniac, and under the excessive heat temperatures the CO is formed and given off. Castings are sometimes packed in hematite ore, and this rich ore is used to decarbonize the castings. From its use arises the term "hematite malleable iron."

There are three forms of furnaces used in the production of malleable—the cupola, the reverberatory or air furnace, and the open hearth furnace. Each has separate points of excellence not found in others, and all are producing satisfactory metal for specified purposes. The cupola is not used very extensively in malleable excepting for the manufacture of specialties, owing to the one great difficulty experienced in combining carbon sufficiently to insure the possibility of pouring large castings; also from the fact that there is no method of puddling or mixing metal except in the tapping ladle. If it were always practicable the cupola would be an ideal method for melting, as the economy in fuel consumption is no mean consideration. At present the cupola is used for the pouring of light shapes almost entirely and in some works the tonnage is very high. One great drawback has been the proclivity of cupola metal to absorb impurities from the fuel, principally sulphur, which metalloid is considered by many authoritative minds to be highly deleterious, although at

the present moment there seems a slight weakening in this respect. Sulphur in steel makes that metal "short," ductility being an impossibility when sulphur is present, and in quantity. In malleable metal a condition often arises in which the metal after annealing will have a crystalline grained fracture, sometimes mistaken for under-annealing. There can be no question that a combination of reactions in which sulphur had played a part, caused this molecular peculiarity, as it is not a natural sequence of the annealing of metal in which the carbon has been, or should have been, in combination at the moment of casting. It might appear from the information available that sulphur in excess has no bad effect upon the casting, but at the same time divergence in practice must be made to comply with prejudices. If consumers would accept metal with a grained fracture the founders would be enabled to make departures in melting. The cupola practically makes no change in the chemical or molecular aspect of the metal; it merely melts. Whatever may be the physical characteristics of the pig iron charged there, will be reproduced in the metal caught at the spout. The molecular change in this metal comes almost entirely with the chilling of metal in the molds at the moment of casting. If the pattern is of sufficient diameter the metal will remain hot for a short moment, and the dampness of the mold being quickly overcome, the result will be that the casting will be gray, and cannot be annealed to advantage. It has always been counted a fact that cupola metal is hotter than air furnace metal, on account of the method of melting; and it is also generally conceded that the cupola metal, being higher or richer in graphitic carbon and silicon, is hotter by virtue of these contained metalloids, while air furnace metal is hot only because of the induced heat of the furnace. This fact of cupola metal being always gray when poured into large castings, precludes the possibility of success in this particular. In only one instance has this class of work been poured successfully and that is in the instance of so-called semi-steels, when the combination of carbon has been effected through the liberal use of sulphide of iron. With this latter mixture the cupola performs

its work as satisfactorily as the air furnace, and metal is first-class for purposes intended. Using the best grades of charcoal and coke irons together with liberal percentages of sprues or gates, there is no difficulty in producing small castings, and the range of cupola work is covered by the word "small." Carriage and harness trimming, pipe fittings, etc., are the main tonnage at present.

The reverberatory air furnace is the generally accepted type for malleable purposes. There are more of this style in operation than any other, and yet there are some classes of work which can be better produced in another furnace described later. There is nothing in its appearance suggesting complex construction. It is a very simple affair, and yet when its lines have been changed even slightly, the foundryman is thrown out of reckoning at once. The air furnace was the original casting hearth, and has certainly withstood all suggestions of improvements. The reason is that nothing simpler could be designed. For many years the mixture has been made up from the fracture of pig, together with the grading and calculation of silicon by allegation. There was no attention given the other metalloids. The advance of chemistry brought wonderful hopes for dependence upon the worth and reliability of other impurities, but outside of the heat conditions of the first casting at the blast furnace (which are contained in the metalloid silicon) the others have failed to come up to expectations. A heat condition must be realized and recognized before a mixture can be calculated successfully. In the old days when a heat was selected, there was always a large proportion of No. 1 or rich iron chosen. A heat condition was in vogue, though possibly not then recognized as such. In modern practice the effects of all the metalloids are understood, but are not given ranking with silicon. Carbon as ever is all-important, but without the presence of silicon its action is void, indeed. No better illustration of the dependence placed upon silicon may be had than if, in making up a heat for air furnace, a No. 5 iron should be substituted for No. 1. The metal when tapped could only be poured into large castings, as its carrying powers would be at once curtailed.

The theory of flame-influence upon metal in bath is the same in reverberatory furnaces as in all melting hearths, namely, a reducing and oxidizing force. In earlier days when the charge was so rich in soft irons, together with small quantities of sprues, there was no possibility of reducing the silicon and effecting the combination of carbon except under continued periods of forcing. The sprues which to-day are accounted the best factor in the mixture were allowed to accumulate, and were eventually sold for scrap. The idea of adjusting the heat through the manipulation of contained metalloids in pig was not in any degree attractive. It was all made upon grade and fracture, consequently when charged it could not be hurried along, but rather was allowed its own time to develop. The same feature is present to-day, of rushing a heat in which the percentages are not thoroughly calculated, and the combination of carbon is effected by means of forced heat. When this is being done the carbon, on account of this hasty and imperfect treatment, will revert again to the graphitic state, thus rendering the castings worthless. A heat of malleable cannot be forced successfully beyond the capabilities of its chemical constitution, which affects these combinations; but heats may be made up from exactly the same irons and sprues, and some will be ready to tap in four hours while others will require six and seven hours.

It is this knowledge of metallurgy, chemistry, and manipulation that marks the best melters to-day. The advance in melting has been coincident with the demands of tonnage, which makes it necessary to melt three heats in the time formerly required for one, and using the same grades of iron as before. It is the constant application of the knowledge of effects produced by the various ingredients that has advanced the melting ratio so greatly. In this respect the air furnace easily proves its worth over the cupola. Heats are charged and the burden of responsibility for their development rests with the silicon content. Carbon is no longer given precedence in calculating, as we are recognizing a heat condition accompanying carbon, and the certain percentages of silicon, contained in the pig, work out the physical prob-

lems of melting. For light castings the silicon runs from .90 to 1.25 and is the metalloid which promotes the fluidity of the metal, as it is the natural element of contained heat.

That carbon is not, and cannot be the controlling influence for fluidity is no better proved than when contrast is made between heats for light and heavy work. The carbon content in both varies but slightly, the silicon radically and the fluidity or staying qualities of the heats bear no comparison whatever. In air furnace practice for light castings of small diameters and varied shapes, where it is a question of pouring iron sufficiently hot to run patterns, the combination of carbon is effected to a great extent by rapid cooling in contact with damp sand. In respect to heavy castings of deep diameters the carbon must be combined in furnace before tapping, and this is brought about with the smaller amounts of silicon, thus reducing the initial heat of metal. This allows the metal in large castings to "set" quickly. Were there a high percentage of silicon present in heavy work mixtures, the castings would retain fluidity long enough to allow graphitic carbon to precipitate, and be disseminated throughout the castings, which therefore would be gray and worthless.

The time of heat in the reverberatory furnace depends upon how refractory the charge may be. If the iron charged is rich, the heat will come up much more quickly, and the iron be hotter than if the charge were "lean" or high iron; for after the latter is melted it must be heated still further by the artificial means at hand, as it contains no latent heat energy in itself. The quality of coal used and the pressure of blast have a very important bearing in this style of furnace. A soft blast is much to be preferred, depending in a measure upon the quality of coal used. With high blast pressure there is always a tendency toward dirty metal, and the chance for occluded gases causing blow holes below surfaces greater. Again, should the blast be too strong there will be a large loss in oixidization, for after the metal is skimmed the flame will have every chance for play. The loss in furnace by oxidization is sometimes as high as 12½ per cent of the total

charge. The overhead blast, or air introduced over the fire bridge wall, has had a great influence on this latter loss in furnace.

The size of air furnace is growing larger every year. Some of the later ones melt as high as 16 and 18 tons—this, of course on heavy work, when the metal is carried away in large ladles. The melting ratio has been very general, and it takes from 40 to 50 per cent coal to melt one ton of iron charged.

The Siemens-Martin acid open-hearth furnaces have been the latest style adopted into the malleable casting industry. Its sphere has been heavy work casting entirely, and we have yet to hear of its continued success on light work. These furnaces melt through the influence of a hydro-oxygen flame. The hydrogen is from the carburetted hydrogen of coal gas, and the oxygen from the atmospheric air. These gases before they are combined are heated by the exhaust heat of the furnace, which in ordinary constructions passes directly to the stack, but in this style furnace is utilized to heat a chamber composed of brick checker work. The atmospheric air is introduced by means of a valve into the chambers and enters the furnaces very hot. One feature of these furnaces is economy in fuel; another the possibility of melting iron away from the contaminating impurities contained in coal and coke. This furnace is much hotter than air furnaces and better brick are required in construction. The temperature of the bath rises after the melting point to 3.500° and 4.000° Fahr. The make-up of a heat does not vary greatly from other practice, excepting that it will carry higher percentages of wrought scrap. This latter on account of its low carbon, forms an attractive feature in the mixture. The flame being very intense oxidizes the metal rapidly, and the combination of carbon is effected, beyond doubt, long before the metal is hot enough to flow. For the manufacture of railway couplers, draft-rigging and all car-body work, this furnace produces a metal which for uniformity stands alone. The metal after annealing is softer and tougher on account of the low carbon content.

This furnace is always under perfect control, as not only may

the supply of gas and air be governed in the valve passages, but also, if necessary, the production of gas may be shut off at a moment's notice and re-started in the same. It will thus be seen how substantially this furnace competes with air, or other reverberatory hearths for all the purposes required. The economy in fuel is estimated at fractionally one-half (when making comparisons), even when the same grade of coal is being considered, and the possibility of using the poorer grades, such as "slack," which may be converted into perfectly clean gas, away from the furnace, forms an advantageous arrangement indeed.

During the progress of a heat in the open-hearth furnace several phenomena are observed which do not occur in air furnaces. One is the visible fermentation taking place in the bath. This latter is especially distinguishable in heats where the charge is rich in graphitic carbon. White iron does not act in this manner. The cause for this phenomenon may be explained by the fact that with the evolution of gas generated by the combination of oxygen and carbon, small particles of iron are drawn to the surface, and burning there for a moment with bright scintillation disappear as the gas has spent its energy, when there is nothing left of these particles of iron to attract gravity. This latter feature is of course one of the principal reasons for furnace losses in melting. As this action increases the iron in bath coagulates or becomes granular. This feature will also appear on the top of ladles, when iron has been superheated. This furnace, as before stated, is most suited to the casting of heavy work, and often during the progress of heats a small quantity of ore has been introduced as an advantage in reducing carbon, etc. This should be used, however, with great caution, as the reaction being very positive, if used too strongly, will produce dull metal, as the latter has already lost considerable of its carbon and silicon.

The road to a direct metal in malleable (thus avoiding the long annealing process) lies in this direction. This metal must be low in carbon, etc., and still have fluidity to run in green sand molds. This has been the stumbling block in every experiment tried in this connection. There has been no difficulty in produc-

ing a low metal, but it was always a "mongrel" steel, requiring a hard mold, and of course it is easier to anneal castings than to dry molds. Therefore the field is still open. The open-hearth furnace is not restricted to the use of producer gas, but natural gas and fuel oil may be used, there being very slight mechanical changes necessary for their adoption.

The annealing of malleable cast iron is a very lengthy operation, and many unsuccessful attempts have been made to shorten it. Its duration may be said to vary with localities and mixtures, for we hear of firms whose practice is a four-day anneal, while others require ten, and claims made that patterns are similar. The annealing oven is of very simple construction, there being nothing in its operation which requires high operative ability. Its only chance for success depends wholly upon the condition of the metal in castings, as they come from the melting furnaces. It possesses no power whatever to change the chemical and physical complexion of metal, beyond the elimination of certain percentages of carbon and silicon. We often hear of metal being "burnt" in the anneal. No metal can be burnt unless it is brought in direct association with a reducing flame, and should the metal have the appearance of burnt iron, it may be depended upon such was the condition of the metal when tapped at the melting furnace. The annealing oven cannot overcome any defect arising at casting. There is nothing but heat in the ovens and nothing but heat will affect the anneal. And again much is insured in the quality of metal by the time allowed the furnaces to cool down. The only chance for material change in the anneal is the small operation or reaction due to charging packing with sal-ammoniac, etc., and this action will be uniform. There are times when some of the iron charged into ovens will be perfectly annealed, while other parts will be hard iron, but this would seem a faulty construction rather than inequality of metal. In an oven, when the anneal is uniform, it is impossible for some iron to be burnt and the balance to be found in perfect condition. Beyond a certain set limit the annealing furnace has no power whatever to influence the complexion of metal. A

furnace may be driven hard enough to cake all the packing, yet the iron has been very ductile indeed. This phase is often met with. Annealing ovens may be fired with any material, which will furnish the degree of heat required. Coke, coal, oil, natural and producer gas, all work satisfactorily. In general practice the heat required is between 1,500° and 1,900° Fahr.

THE TRADESMAN.

Answering a question regarding the cheapest plan for turning out plow shares, landsides and the necessary chills for same, Mr. E. H. Putnam says:

Patterns for chills are made in plaster to exactly fit the face of the pattern where they are to be used simply by casting the plaster upon that part of the pattern. Suppose you wish to make a chill pattern for a plow point.

First, provide a box about eight inches deep by, say twenty inches square, more or less, as you please, but be sure to have room enough. Now fill this with hardwood sawdust, which should be first sifted through a No. 8 riddle. Wet the sawdust so that it can be built up into a vertical wall that will remain in position. Now, oil the share pattern where the plaster is to come in contact with it, and imbed it bottom up in the sawdust, and, using a small, thin board, build a wall of sawdust around the space that is to be chilled, and make it high enough so that the plaster cast will be an inch thick at the thinnest place. Provide for a quarter inch of stock on both sides, and an inch at the small end. The point chill, when finished, should extend beyond the edge of the share about one-quarter inch; at the tail end, one and a half inches, and on the land side of the nose it should be one-half inch thick.

The edge of an ordinary one-horse plow should be chilled back to about five-eighths inch; of a two-horse plow, seven-eighths inch. Anything wider than this on any plow is superfluous, and adds to the difficulty of casting. Having gotten the sawdust mold shaped to suit, mix a quantity of plaster to a consistency between thick and thin, and pour it. About an hour

hence (and in less time when you get used to it) take up your plaster cast and scrape off the adhering sawdust, and, with a small hand saw, trim to something like what is wanted, though taking pains not to cut too close. The rest of the work must be done with a wide, thin-edged chisel, smoothing, at the finish, with sand paper, though never touching the face side.

The chill for a two-horse share should be half-inch thick at each end and seven-eighths-inch at the middle. Let the finished pattern dry over night, and before molding, next day, try it on the pattern and see if it fits perfectly. Plaster paris will change its shape sometimes. I never knew but one man who could make a chill pattern of plaster for a plow mold that would never warp; in my experience they sometimes warp, and, therefore, it is always best to try them before molding. This is done by mixing a little red lead in oil and painting the share pattern on the edge, and then, carefully laying on the chill pattern and moving it a trifle so as to cause the paint to adhere where it touches hard. This is a delicate operation, and the novice is apt to make the mistake of bearing down too hard in trying the pattern, thus bending it, and causing it to touch the paint where it ought not. Bear this in mind and you will have no trouble. If the plaster pattern does not show paint pretty evenly all over its face, it must be carefully scraped, in such a manner as not to materially alter the proper contour, and the operation of trying and scraping must be repeated till a fit is attained. Do not varnish the chill pattern; mold carefully so as not to spring it in the least, and draw without rapping; simply thrust the finger nails into the edge and lift; this will give you a perfect mold, which should be set upon a solid bed, previously prepared, in such a manner as to preclude the possibility of warping. Gate it at the end. The casting from this mold should fit the edge of the plow share pattern almost perfectly; and if it do not, it must be made to, before fitting up for a pattern.

The pattern for landside chills is most easily made of wood. It should be ¾-inch thick everywhere. The landside for a two-horse plow should be chilled at the heel only. The bottom of

the landside should be chilled to the full width, for about 8 inches, extending forward from the back end; the side, the same distance, and extending up the side about two and a half inches at the end, and sloping to say, one and a half inches at the forward end, having the forward upper corner rounded somewhat.

Ordinary soft iron is the best material for chills; but this will not do at all for shares and landsides. Though the iron for landsides ought to be somewhat harder than for shares, still, many people make no distinction, and where only small quantities are made it is difficult to produce the different grades with precision.

It is impossible to state the exact percentage of the different irons that must enter into the mixture for any particular kind of chilled casting. All plow makers vary their mixtures from time to time. This is necessary in order to produce uniform results. The percentages of the metalloids vary more or less in both the pig iron and the scrap, and the grade of mixture must therefore be governed by close observation of results from day to day.

One important thing to be borne in mind is that you cannot make good chilled plow castings without charcoal iron. You do not have to use all charcoal iron, but you must use a certain per cent. of it in order to produce a strong casting, with a good chill. Coke iron is not a chilling iron, and the only way that you can make chilled castings from it, alone, is to use iron in which the carbon is already combined to a great extent. A mottled gray forge iron mixed in certain proportions with No. 3 foundry, would make a chilled share; but the share would be so brittle that it would be apt to get broken before it should reach the final purchaser. Another difficulty with this iron is that you never know whether your shares are going to be chilled on the edge, and have a gray body, or whether they will turn out white all through, and, consequently, weak and worthless. You must depend for chilling quality upon charcoal iron. And remember, too, that there are two kinds of charcoal iron: viz., chilling, and non-chilling. Always order, specifically, chilling iron, for plow castings. (The non-chilling charcoal iron is used in making malleables, and in semi-steel.)

To make first-class plow shares, the chilling tendency should be very pronounced. Such iron, cast without a chill, will be gray all through, and very strong; but, wherever the chill comes in contact, it will quickly solidify, and remain hard and white, but it will be gray and strong everywhere else; therefore, it produces a very strong, well-chilled, good-wearing share.

It is not necessary, however, to use all charcoal iron in order to produce these results.

You may find the following a good mixture to start with, varying it according to need:

Sixty per cent. chilling charcoal iron No. 5, 40 per cent. coke (foundry) iron No. 3. The remelt (that is, the sprues and other scrap from this mixture) will, in use, greatly modify this rule.

Bearing in mind all the above, any ordinary good foundryman ought to be able to make good plow shares. I assume, of course, that the foundryman knows that the fuel must be approximately free from sulphur. Iron takes up sulphur from the coke very rapidly, and the casting product will be apt, where sulphur is in excess, to have a honey-comb appearance, resulting from occluded gas, and it will be very weak. Furthermore, where sulphur is in excess, it is impossible to control the mixture—it will sometimes be too hard and sometimes too soft. In the south, the Flat Top Pocahontas foundry coke is mostly used. The ordinary southern make coke, such as is used in blast furnaces, is unfit for the cupola. There is, however, a coke made at Chickamauga which cannot be excelled for foundry use. At least, this is true of the sample that I used some years ago when I was conducting a foundry in Tennessee. I understand that the coke is now being made in large quantities. The name of the firm is, I believe, The Chickamauga Coke Co., but, wherever you get the coke, be sure that it is "72-hour foundry coke."

Noting the tendency to locate foundries above the ground floor, the same author writes:

Not many years ago it was the universal practice to locate foundries on the ground floor. The first deviation from this was in large cities, where land values were high, and this led to the

occasional employment of a basement for foundry purposes. In this case artificial light was employed. This plan was never satisfactory. Molding requires good light, better light than can be afforded by artificial means. Furthermore, the air of the basement is not good, and a civilized man won't live in a cellar if he can help it. True, many forms of industry are prosecuted in basements, but the peculiar conditions pertaining to iron founding render it one of the least fitted for subterranean location. Moth and rust gather fast in underground places, and this circumstance is greatly aggravated by the varying temperatures, and by the gases and steam of the foundry. The underground foundry was, at a stretch, barely practicable in times past, when competition was a baby; but now that this interesting person has grown to athletic proportions, and never for a moment lets up in his war against abnormally high profits, the basement foundry is no longer "in it." The economies possible in high, dry, airy and well-lighted foundries have knocked out the cellar. Another thing: You couldn't get molders to work in such a foundry to-day.

The foundry is passing from the ground floors to the upper floors to-day, and it is nothing at all uncommon to see a foundry on the second floor, and some go even higher than this. And why should they not? There is nothing whatever in the way of it. Of course, very heavy work can be done with greater advantage on the ground floor; but all sorts of light work, including general agricultural machinery, may be done on the upper floor with equal facility. The floor in such a foundry may be made of either brick or cement; I should consider the latter preferable.

The new foundry of the Moline Plow Co., at Moline, Ill., is a splendid example of modern construction. It is a steel skeleton, with brick walls, tile roof and cement floor, the latter laid upon arched, corrugated sheet steel, the ends of the arched sections resting on the lower flanges of I-beams, spaced about five feet apart. It is a two-story structure, 150x175 feet. The molding room is on the upper floor, the cupola standing upon a brick pier

extending up from a base of concrete in the ground below. The engine is on the ground floor, and here also are stored the iron, coke, sand and all raw materials; also flasks, follow boards, etc. The cleaning, inspecting and finishing of castings is done on the first, or ground floor. A large elevator lifts the stock and other things to the foundry room, or to the cupola scaffold, but the casting product is shot down through the floor on an incline to a raised floor, from which it is placed in the tumbling mills, which are on the ground floor. In this way the available room is double what it would be by the old style of construction, while general convenience and comfort are much greater. The first story is very high, giving room for a double row of windows, and this raises the foundry proper, or molding room, high above the dust and noise of the street, and gives abundance of light and air, the principal wall space being constituted of windows, the M-roof having two very wide and high ventilators extending the full length of the building. There are many other advantages in a foundry of this construction. No insurance is required, for there is nothing about the building that can burn except the windows. And not least among the agreeable features is the difficulty of access by persons who have no business on the premises.

THE FOUNDRY.

R. D. Moore, writing of "Shrinkage Strains," says:

In considering internal strains it has long been known that large bodies of cast iron, in compact form, as for example a sheet roll, or a solid shaft, do not possess the full strength of the same material when cast into structures of less thickness.

It has been a matter of observation among lathe hands that when the turning tool reaches deep into the metal of a large shaft, the chips "come off easily," and the iron appears to be looser in the central portion. Evidently the compactness, or density, of the metal decreases as the mass increases.

The reason for this is very obvious. In cooling, the heat is necessarily conducted away from the outside first, which, after a time becomes solidified, then follows the next imaginary layer

and so on, layer after layer, until solid to the center. This order of cooling is kept up until entirely cold, that is, each internal layer shrinks slower and requires longer time than the next adjoining outer layer; the consequence is that every particle of metal is under constraint, that is, pulling inward on the next adjoining outward particle, leaving not a single particle in the whole mass that can be said to have exactly reached a position of repose.

This strain is not merely in a radial line only, but is also exerted in the two other lines, the tangential, and the longitudinal lines. Saw a two-inch section from the middle of a roll and you have a casting like a wheel in its outline and resting under precisely the same kind of strain that breaks the wheel, that being an internal strain, produced by the hub continuing to shrink after the rim has ceased to do so, as is evident by the separation of the arms at the fracture.

It has been repeatedly observed that the iron yields after a time, when under a great shrinkage strain. Cannon balls are known to diminish sensibly to the calipers for some time after casting. The outer shell evidently yields gradually to the internal pull, the movement extending to the very center and partially relieving the casting of its original strain.

Experiments have attested that cannon stand a heavier strain if allowed to rest several years before testing. The same relief is known to occur in wheels, they being much less liable to break if not used for a considerable time after casting.

This internal strain will necessarily be greater in a chilled roll than in a soft one, the rapidly conducting chill increasing the disproportion between the external and internal cooling. An interesting experiment is recorded where this was observed. Two experimental cannons were cast in Boston in 1847 for the United States, from the same melting, one in a mold heated to redness, the other cold. The former, in a test, proved much superior in strength. The red-hot mold prevented somewhat the unequal cooling that causes the internal strain under consideration.

A piston packing ring, say 1½ inches thick, exhibits a strong proof of this "pull." If we turn the outside only, when split,

the ends would stand apart slightly. In this case the distance from the skin to the center of the metal is only ¾ inch, but by turning off only 3-16 inch we have arrived at a point where the metal cools slower and requires longer time than at the outside; this is very delicate hair splitting, but sustains the theory laid down.

If the turning of the outside of the ring was continued nearly to the center, the gape would increase at every cut, because a still later shrinking section would be brought to the outside, increasing the outside pull, as a tight band.

If this internal strain is so perceptible in a thin casting what must it be in a "solid cast" cannon or a 24-inch roll, presenting a distance to the center of metal many times greater. In this connection it is proper to note that the heat added to the roll while at work also adds greatly to the strain originally contained when it left the lathe, and in exactly the same directions.

These two added strains on a roll are very difficult to, even roughly, estimate; we can simply call them enormous. In view of these facts it is more than probable that a shaft with a hole cast through it is stronger than a solid one, because the force that tears the metal particles asunder, is reduced by reducing the distance from the skin to the center of metal, or we may say by removing the central portion, which causes the most trouble.

An experiment showing how large a core would add the greatest strength to such a casting, would be very interesting if ever made.

One of the most interesting experiments ever tried to overcome the disastrous effects of this shrinkage strain, was in the casting of what was known as the Rodman cannon.

Clearly understanding the weakening effect of this internal strain upon cast iron cannon, led Capt. Rodman, of the United States army, about 1850, to introduce a new system of cannon founding, with the double object of not only preventing the internal strain, but at the same time producing a strain that would act in an exactly contrary direction.

For illustration, suppose we imagine a cannon as cast by placing one thin shell over another, slightly loose, until the usual thickness is obtained. It is clear that when the strain is exerted upon the inner shells, that it will be burst very easily, before the next shell can receive the full strain; the next shell, in its turn, receiving the full force, gives way also, and so every one is easily torn asunder. The cannon under internal strain has its different imaginary shells similarly situated, they having attempted, and to some extent, succeeded, in tearing loose from the next outer shell. The strain in an opposite direction, as produced by the Rodman process, may be illustrated by imagining a gun constructed with a shell, the inside representing the bore of the gun; then a second shell, slightly too small to pass over the first, but which by heating can be expanded to receive the first one. On cooling the outer shell will shrink very tightly on the inner one; and the process may be so repeated until the gun is completed.

It is clear that in a gun thus constructed, all the bands resist the strain at the same instant, and that very nearly all the strength of the metal is made available at the time of explosion. It is more than probable that this external, or "hoop" strain, carried beyond a certain limit, may be detrimental to the strength of the gun.

The initial tension of the Rodman gun was determined by cutting a ring off the lower end of the feeding head and planing a radial cut. Just before the cut passes through, the ring snaps, and the amount of gape gives the relative tension. The government adopted as a rule of tension on a 15-inch gun that the radial cut should open 1-10 to 2-10 inch more on the outer end than the inner one.

Capt. Rodman, by his system of internal cooling, produced a strain very similar in character to that in the example given, and in much the same manner; namely, by cooling the inside layers of metal first, or exactly the reverse of the old method. This mode of cooling was accomplished by passing a current of water through a pipe down to the bottom of the core barrel, then flowing off at the top, the water being started just before casting. The core barrel was, of course, water tight. Grooves being formed on the outside to convey the gases to the top.

The government made a great variety of tests of the difference in the strength of guns cast from the same melting, and the results all showed the superiority of the Rodman process over the old method. It is well known that the Rodman device, as applied to cannon casting is of no value to-day because of the introduction of the modern forged gun, but it still remains an interesting subject, to foundrymen, by throwing light on the different strains of other structures of cast iron.

A foundryman asks Mr. W. J. Keep to give him a remedy for blow holes occurring in small cast iron shells weighing about 40 pounds, and which are 14 or 16 inches long, and 4¼ inches in diameter. These are cast on end, and the vent is taken off through a small gas pipe on which the core is formed. The cores are made with boiled linseed oil, just as small a quantity as can be used and have the cores stand the strain of being strengthened on the pipe. The iron is required to have a tensile strength of 23,000 pounds per square inch in a turned test piece. A good quality of clean scrap is used with No. 2 pig iron, and some steel turnings are mixed in the ladle with the melted iron. The turnings are generally clean, but have more or less salsoda or soap on them from the machine shop. The castings have a good many blowholes under the skin, and often in any other part of the casting. A blowhole, however small and ⅛ inch deep, condemns the casting, and at least one-fourth of the production is condemned for this cause. The castings have been poured both hot and cold with no appreciable difference in this respect.

Replying to the above, Mr. Keep writes:

If the iron enters the mold from the bottom it would be well to set a riser on top and allow some iron to flow through the mold so as to move the holes from the surfaces of the casting.

By pouring the iron hot the bubbles of gas can rise and reach the top, while with dull iron they would be caught in the body of the casting.

By making the gate so that the iron will enter the mold at the bottom the gate may be shaped so as to give the iron a whirl in the mold and the blowholes would work to the center and might disappear altogether.

The trouble in this case seems to be caused by the steel turnings that are mixed in the ladle with the melted iron. The melting point of steel is higher than that of cast iron, therefore steel turnings are not likely to be melted in a ladle when mixed with melted cast iron. The instant that a particle of steel is brought near the fluid iron its surface becomes covered with an oxide. This oxide produces a gas when the casting cools which is very likely to form a blowhole.

The turnings of steel do not melt so as to form a perfect chemical union with the cast iron, but is mechanically mixed and is likely to cause trouble at any time. When a high tensile strength is required the addition of steel scrap will give the strength if it comes near enough to being melted to mix generally through the mass. The steel scrap should be charged in the cupola along with the pig iron, and 10 or 15 per cent of steel scrap will be beneficial and help to meet the requirements regarding strength.

When steel borings or turnings are added in the ladle, they are sometimes not melted, but the oxide-covered particles of steel will be carried along with the fluid iron and enter the mold and be caught in the mass of the casting. In such case each little piece will be very likely to form a blowhole.

In pouring cast iron, if the iron strikes the bottom of the mold so as to splash, the little drops will be instantly covered with an oxide, and when the fluid iron covers them a blowhole will form around the little piece which will lie loosely in the hole.

Even when steel chips are charged in the cupola, often particles covered with oxide will not melt, and as a consequence a casting will sometimes be honeycombed with blowholes and loose grains.

The best way to melt very fine chips of cast iron or of steel is to spread them on the sand bottom of the cupola before the kindling is put in, and they will be heated nearly to melting by the fire, and will be covered with the melted iron that accumulates before the first iron is drawn off.

Adding steel scrap to melted cast iron reduces the percentage of carbon, which change makes the melted iron less fluid. It is very difficult to make melted steel hot enough to fill a mold, and the addition of 10 or 15 per cent of steel scrap in the cupola lowers the carbon percentage of cast iron enough to materially lessen the fluidity of the iron. The less fluid the iron the more blowholes in the casting, because gas cannot rise freely to the top and escape through the porous walls of the mold.

When castings are made of steel alone, small pieces of high silicon pig iron are added to make the metal more fluid. A little aluminum added to the ladle will so increase the fluidity of the metal as to allow the gases to escape and perfectly solid castings will result.

Probably in the present case the best way out of the trouble is to add somewhat less than one-tenth of one per cent of aluminum in the ladle and pour the metal hot. Some small pieces of ferrosilicon may do the same thing.

The metal is made so fluid by the aluminum that the impurities will rise and the gases will escape through the mold, or perhaps the gases are prevented from separating from the melted iron. If steel scrap is added to the charge, increase the coke a little, because it takes more fuel to melt steel than pig iron, and because iron containing steel must be hotter to run, and it should be fluid enough to let the gases get out.